IN THE U.S. PATENT AND TRADEMARK OFFICE

In re application of

David Anthony STAFFORD

Application No. 10/820,758

Filed April 9, 2004

APPARATUS FOR AND A METHOD OF TREATING ORGANIC WASTE

CLAIM TO PRIORITY

Assistant Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

May 4, 2004

Sir:

Applicant(s) herewith claim(s) the benefit of the priority filing date of the following application(s) for the above-entitled U.S. application under the provisions of 35 U.S.C. § 119 and 37 C.F.R. § 1.55:

Country	Application No.	Filed
BRITAIN	0308366.4	April 11, 2003

Certified copy(ies) of the above-noted application(s) is(are) attached hereto.

Respectfully submitted,

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Attachment(s): 1 Certified Copy(ies)

The Patent Office
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P01/7700 0.00-0308366.4

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1. Your reference

MRH.P04789GB

2. Patent application number
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0308366.4

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

Enviro Control Limited
26 Forsythia Drive
Greenways
Cyncoed
Cardiff, CF2 7HP

Patents ADP number *(if you know it)*

6760631001

If the applicant is a corporate body, give the country/state of its incorporation

United Kingdom

4. Title of the invention

APPARATUS FOR AND A METHOD OF TREATING ORGANIC WASTE

5. Name of your agent *(if you have one)*

Marks & Clerk

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

27 Imperial Square
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GL50 1RQ

Patents ADP number *(if you know it)*

18014

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

a) any applicant named in part 3 is not an inventor, or
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Continuation sheets of this form	
Description	10
Claim(s)	3
Abstract	1
Drawing(s)	3 + 3

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Priority documents	
Translations of priority documents	
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
Request for preliminary examination and search *(Patents Form 9/77)*	1
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(please specify)*	

11. I/We request the grant of a patent on the basis of this application.

Signature Marks & Clerk Date 10th April 2003

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Mr M R Higgins
01242 524520

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Notes

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APPARATUS FOR AND A METHOD OF TREATING ORGANIC WASTE

This invention relates to apparatus for and a method of treating organic waste such as sewage sludge and animal manures.

The enforcement of EC Directives and USEPA guidelines on disposal of organic waste and their use in agriculture has brought about changes in sludge disposal practice as well as a need to study the options available and their cost-effectiveness. Treatment is required to reduce significantly the fermentability of the sludge as well as its health hazard due to the presence of pathogens.

According to one aspect of the invention there is provided apparatus for treating organic waste, comprising an anaerobic digester for receiving the organic waste, an aerobic digester, and means for pumping effluent from the anaerobic digester to the aerobic digester, the digesters each having a reaction vessel and one or both of the reaction vessels having a spray nozzle at or adjacent to its apex for spraying an anti-foam liquid onto the contents of the vessel.

The anti-foam liquid could be water or a mixture of water and an anti-foam agent.

Preferred and/or optional features of the first aspect of the invention are set out in claims 2 to 7, inclusive.

According to a second aspect of the invention there is provided a method of the steps of:

a. feeding the organic waste into an anaerobic digester.

b. feeding and mixing the waste in the digester contents in a predetermined controlled cycle.

c. pumping effluent from the anaerobic digester to an aerobic digester.

d. mixing the organic waste in the aerobic digester with air by pumping the organic waste through a venturi mixer which draws air into the organic effluent.

e. measuring the organic content of the effluent fed into the aerobic digester, and

f. varying the flow rate at which organic waste is pumped through the venturi mixer according to the volume and organic content of the sludge fed into the aerobic digester, and

g. spraying an anti-foam liquid at the contents of at least one of the digesters.

A preferred and/or optional feature of the second aspect of the invention is set out in claim 10.

The invention will now be more particularly described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a schematic view of one embodiment of apparatus according to the first aspect of the invention,

Figure 2 is an enlarged view of the spray nozzle fitted to each reaction vessel of the apparatus, and

Figure 3 shows a distribution network for the spray nozzles.

Referring firstly to Figure 1 of the drawings, the apparatus shown therein comprises an anaerobic digester 10, an aerobic digester 11, a feed line 12 connected between the upper end of the anaerobic digester 10 and the lower end of the aerobic digester 11 and a feed pump 13 for pumping effluent from the anaerobic digester 10 to the aerobic digester 11 through the line 12.

The anaerobic digester 10 comprises an insulated anaerobic reaction vessel 14 having an inlet pipe 15, a recycling pipe 16 and a recycle pump 17 for taking gas produced in the vessel 14 from the roof of the vessel 14 to the nozzle 18 in the centre of the base of the vessel 14. The recycle pump 17 is switched on intermittently and only after the feeding regime is concluded on a regular cycle. This can be hourly or

whatever regular cycle chosen for a particular application. Feeding and mixing organic waste in the digester contents is thus in a predetermined controlled cycle. This produces a gentle rolling action for mixing the contents of the vessel.

The anaerobic digester also includes a settlement tube 19 against the inside wall of the vessel 14. This has an inlet 20 above the base of the vessel and increases in cross-sectional dimensions as it extends upwards to the level at which effluent exits the vessel 14. The settlement tube allows the digester contents to exit the vessel 14. The increasing cross-sectional area as the contents move upwards reduces the rate of upflow speed of the contained particles. As a result the larger particles will tend to slow down and remain in the tank for longer than they would normally. This has the overall result of increasing the solids retention time.

The aerobic digester 11 comprises an insulated aerobic reaction vessel 22, a venturi mixer 23, a liquid outlet 24 and an air outlet 25. The venturi mixer 23 comprises a recycle tube 26 connecting the lower end of the vessel 22 to the upper end of the vessel 22, an air inlet tube 27 connected to the recycle tube 26 intermediate the ends thereof and a recycle pump 28 for recycling effluent from the anaerobic digester 10 through the recycle tube 26 and past the inner end of the air inlet tube 27.

The line 12 is connected to the recycle tube 26 at the lower end thereof and

upstream of the recycle pump 28.

Two temperature sensors 29, 30 are mounted in the reaction vessel 22. The temperature sensor 29 is mounted at a position above the sensor 30 so that the temperature of the effluent at two levels in the reaction vessel 22 can be monitored.

A syphon break tube 31 is connected to the liquid outlet 24. In operation, effluent from the digester 10 is fed into the aerobic reacion vessel 22 through the inlet line 12 by the feed pump 13 and is recycled in the aerobic reaction vessel 10 through the venturi mixer 23 by the recycle pump 28.

As the effluent is pumped through the venturi mixer 23 by the pump 28, air is drawn into the effluent from the air inlet tube 27. The quantity of air drawn into the reaction vessel 22 in a given period of time can be varied by varying the flow rate at which the effluent is pumped through the venturi mixer 23.

Because the effluent to be treated may vary as to its organic content (as measured by its contained volatile solids or Biological Oxygen Demand), it becomes important to control the rate of oxidation by means of knowing the incoming organic loading of the incoming effluent.

As the organic loading (measured in terms of kg of Volatile Solids per M^3 of

reactor per day for example) increases, the rate of oxidation and mixing can be increased to provide sufficient aeration capacity for the microbes providing the metabolic heat. This process can be effected automatically by means of an automated BOD sensor and used to control the flow rate at which the effluent is pumped through the venturi mixer 23. Thus, the quantity of air drawn into the effluent can be matched to the volume and strength of effluent fed to the reaction vessel 22 from knowledge of the volume of effluent fed into the vessel 22 by the feed pump 13 and from the organic content of that effluent.

In order to ensure that thermophylic aerobic digestion takes place, the effluent in the aerobic reaction vessel 22 must be maintained above a predetermined temperature and is usually maintained at between 55°C and 70°C. The temperature sensors 29 and 30 monitor the temperature of effluent in the reaction vessel 22 and if this temperature falls below a predetermined value, the quantity of effluent fed into the reaction vessel 22 over a given time period is increased to increase the oxidisable organic carbon in the reaction vessel 22 and/or the flow rate at which the effluent is pumped through the venturi mixer 23 is increased to increase the quantity of air in the reaction vessel 22. The quantity of effluent fed into the reaction vessel 22 can be increased either by increasing the frequency at which the feed pump 13 is operated or by increasing the duration of feed.

In practice, the feed pump 13 will be operated intermittently, e.g. for about

10 minutes every three hours, and during operation of the feed pump 13, the recycle pump 28 can be switched off. This enables the treated effluent to be discharged from the vessel 22 before new effluent is mixed by the venturi mixer 23 with the contents of the vessel 22. In this case, the incoming effluent will be fed into the lower end of the vessel 22.

Alternatively, the recycle pump 28 can remain on while the feed pump 13 is operating. In this case, some of the effluent will be fed into the lower end of the vessel 22 passing through the lower end of the recycle tube 26 against the flow of effluent being recycled through the recycle tube 26 and some of the effluent will be carried round with the recycled effluent and will be fed into the upper end of the reaction vessel 22.

The rate at which effluent is pumped through the venturi mixer 23 can also be increased by increasing the speed of the recycle pump 28 if the differential temperature sensed by the temperature sensors 29 and 30 exceeds a certain value as this will indicate insufficient mixing of the contents of the vessel 22.

Foaming problems have occurred both in anaerobic and aerobic digesters and it is often not possible to identify the single causative agent, although it is generally accepted that textile industry effluent can cause foaming problems in a number of treatment processes. An anti-foam system is therefore included in each digester 10,

11. Without this system the digesters can only be operated at 50 - 70% of their design load and cannot treat all effluent produced on site. Each foam system comprises a spray nozzle 35 mounted in an upstanding extension tube 36 at the apex of each reaction vessel 14, 22. The extension tube 36 has a viewing window 37 at its upper end and a gas vent 38 extending laterally and upwardly from the side of the upstanding extension tube 36. As shown in Figure 4, the nozzles 35 are supplied with an anti-foam liquid, which could be water or a mixture of water and an anti-foam agent, from a tank 40 by pump 41. An isolating valve 42 and a non-return valve 43 are provided in the common supply line 44 for the nozzles 35 and each nozzle 35 also has its own dedicated isolating valve 45, its own dedicated solenoid valve 46, its own dedicated drain valve 47 in the supply to the nozzle 35 and its own dedicated pressure switch 48. The distribution pipes are protected from freezing by trace heating 49.

The nozzles 35 are used to evenly distribute the anti-foam liquid to the reaction vessel to physically disrupt the foam structure within the vessel.

A computer control system has been developed for the apparatus to enable remote monitoring and control. All pumps, motors, agitators etc. can be manually controlled locally in order to facilitate system check-out and start-up. Each device has a local auto/manual selector switch which is interlocked into the logic of the control system. For safety, placing any device in manual mode locks out the

automatic mode.

All pumps, motors, agitators, etc. can be manually controlled locally in order to facilitate system checkout and startup. Each device has a local auto/manual selector switch which is interlocked into the logic of the control system for each skid. For safety, placing any device in manual mode locks out the automatic mode.

Automatic sequencing for the anaerobic digester is accomplished through the use of a programmable logic controller (PLC) in the control room. All analogue and digital I/O passes through a PLC, which allows all devices to be monitored and controlled automatically. All fixed sequences and timing are controlled from the PLC.

Supervisory process control and data acquisition are accomplished through an IBM compatible computer (PC) operating under OS/2 or equivalent. The PC provides sufficient processing power to operate the control software and other programs in true multi-tasking mode. A hard disk provides local storage for programs and operating/laboratory data. The PC communicates with the PLC over an RS-232 interface using the MODBUS communications protocol or equivalent. A high speed internal modem provides remote communications capability for control and data exchange.

The above embodiment is given by way of example only, and various modifications will be apparent to persons skilled in the art without departing from the scope of the invention as defined by the appended claims.

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CLAIMS

1. Apparatus for treating organic waste, comprising an anaerobic digester for receiving organic waste, an aerobic digester, and means for pumping effluent from the anaerobic digester to the aerobic digester, the digesters each comprising a reaction vessel and one or both of the reaction vessels having a spray nozzle at or adjacent to its apex for spraying an anti-foam liquid at the contents of the vessel.

2. Apparatus as claimed in claim 1, wherein each reaction vessel has a spray nozzle at or adjacent to its apex..

3. Apparatus as claimed in claim 1 or claim 2, wherein the aerobic digester further comprises venturi mixer for mixing effluent in the reaction vessel with air, means for pumping effluent in the vessel through the venturi mixer, means for measuring the organic content of the effluent fed into the vessel and means for varying the flow rate at which the effluent is pumped through the venturi mixer according to the volume and organic content of the effluent fed into the vessel.

4. Apparatus as claimed in claim 3, further including means for monitoring the temperature of the effluent in the reaction vessel and means for increasing the quantity of effluent fed into the vessel over a given period and/or increasing the flow rate at which the effluent is pumped through the venturi mixer if said temperature

falls below a predetermined value.

5. Apparatus as claimed in any one of the preceding claims, wherein the anaerobic digester comprises a mixing chamber and means for recycling gas produced at or adjacent to the apex of the reaction vessel into the lower end of the vessel.

6. Apparatus as claimed in claim 5, wherein the recycling means comprises a recycle pump and a nozzle at or adjacent to the lower end of the vessel.

7. Apparatus as claimed in claim 5 or claim 6, wherein the anaerobic digester further comprises a settlement tube to increase the retention time of solids in the vessel.

8. Apparatus for treating organic waste, substantially as hereinbefore described with reference to the accompanying drawings.

9. A method of treating organic waste comprising the steps of:

a. feeding the organic waste into an anaerobic digester.

b. feeding and mixing the waste in the digester contents in a predetermined controlled cycle.

c. pumping effluent from the anaerobic digester to an aerobic digester.

d. mixing the organic waste in the aerobic digester with air by pumping

the organic waste through a venturi mixer which draws air into the organic effluent.

e. measuring the organic content of the effluent fed into the aerobic digester, and

f. varying the flow rate at which organic waste is pumped through the venturi mixer according to the volume and organic content of the sludge fed into the aerobic digester, and

g. spraying an anti-foam liquid at the contents of at least one of the digesters.

10. A method as claimed in claim 9, wherein the anaerobic digester includes a settlement tube to increase the retention time of solids in the vessel.

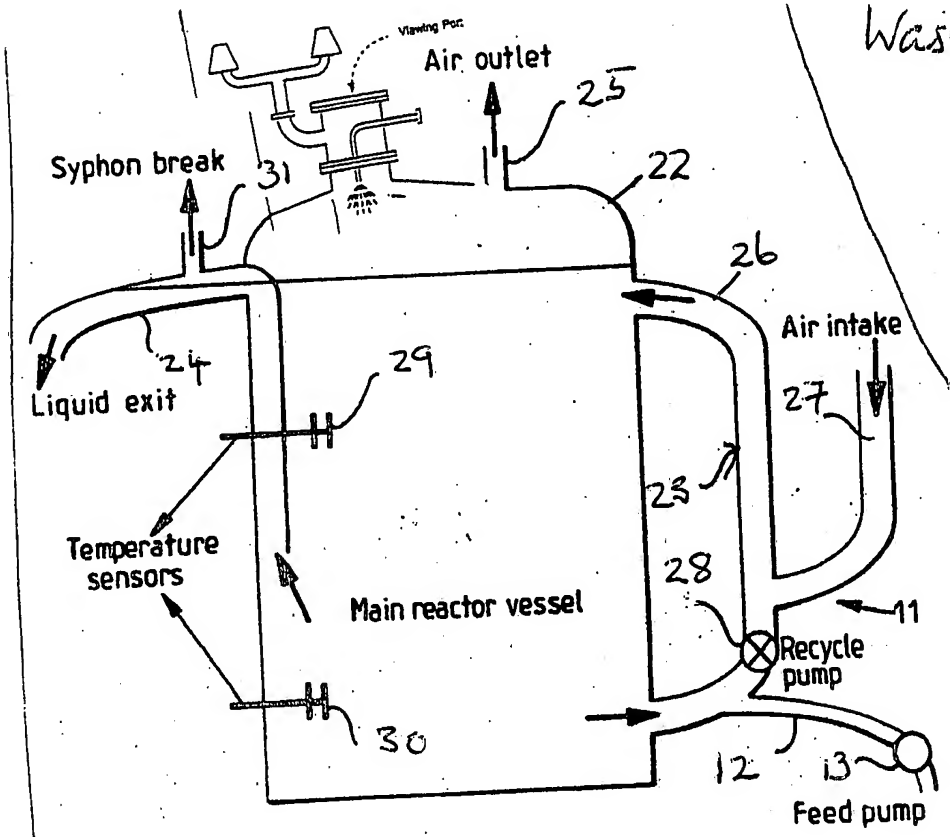
ABSTRACT

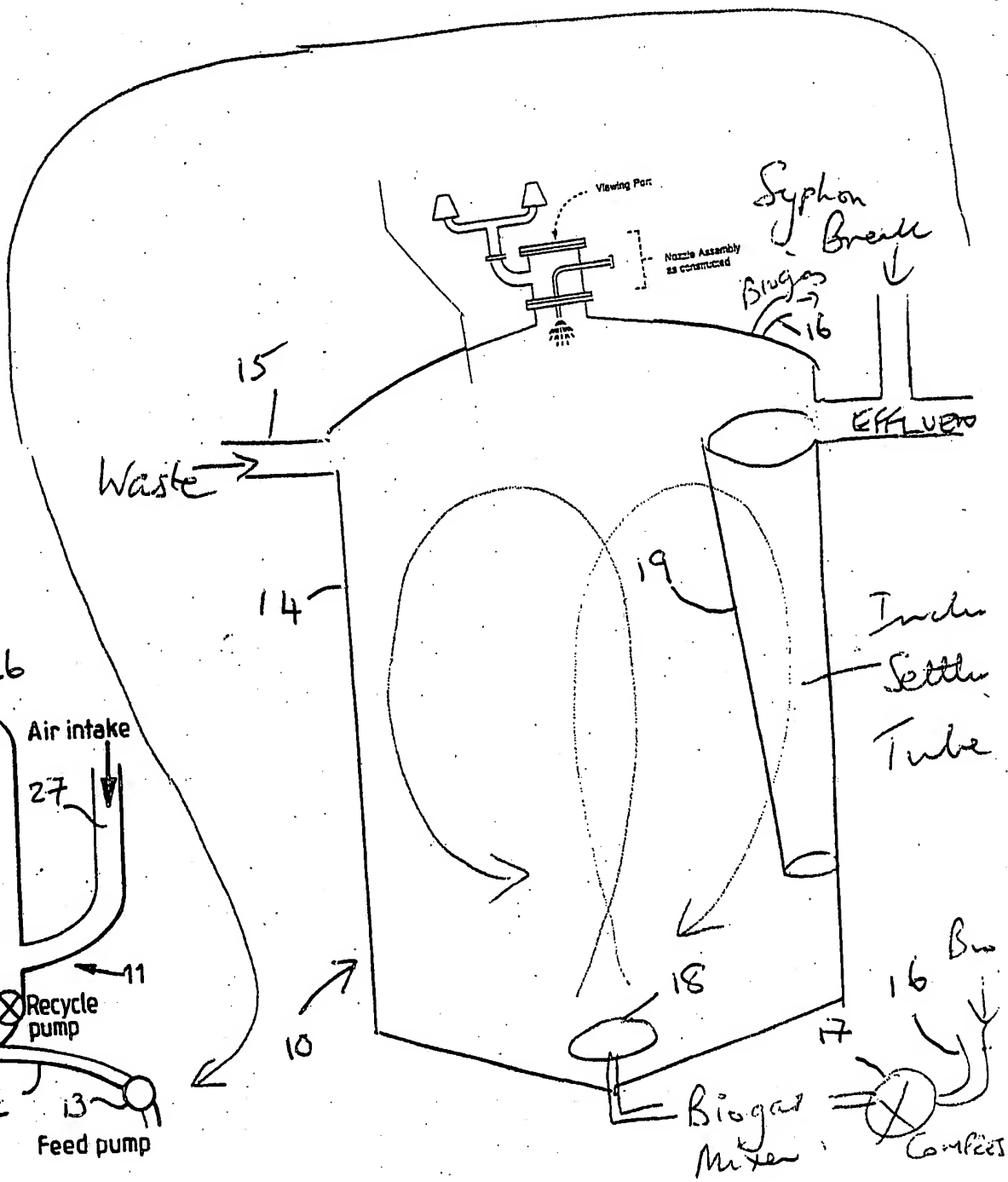
APPARATUS FOR AND A METHOD OF TREATING SEWAGE SLUDGE

The apparatus comprises an anaerobic digester 10 for receiving organic waste, an aerobic digester 11, and a feed pump 13 for pumping effluent from the anaerobic digester to the aerobic digester. The digesters each comprise a reaction vessel and one or both of the reaction vessels has a spray nozzle 35 at or adjacent to its apex for spraying an anti-foam liquid at the contents of the vessel. A method of treating organic waste is also disclosed.

(Refer to Figure 1)

FIGURE 1


Viewing Port
Air outlet
25
Syphon break
31
22
26
Air intake
27
24
29
Liquid exit
23
28
Temperature sensors
Main reactor vessel
11
Recycle pump
30
12
13
Feed pump


Viewing Port
Nozzle Assembly as constructed
Syphon Break
Biogas
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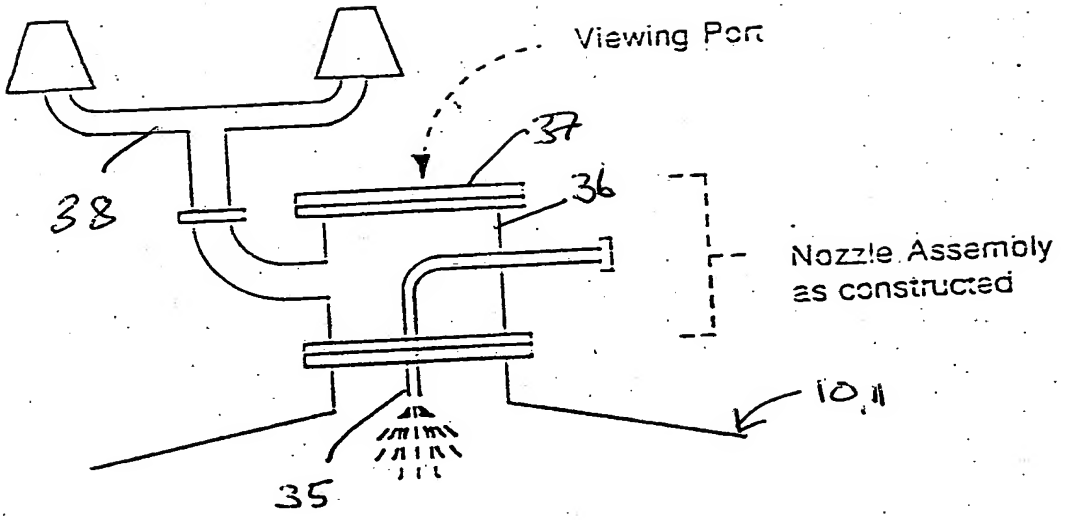
15
EFFLUENT
Waste
14
19
Inclin
Settle
Tube
10
18
16
17
Biogas
Mixer
Compres



Proposed Arrangement

FIGURE 2

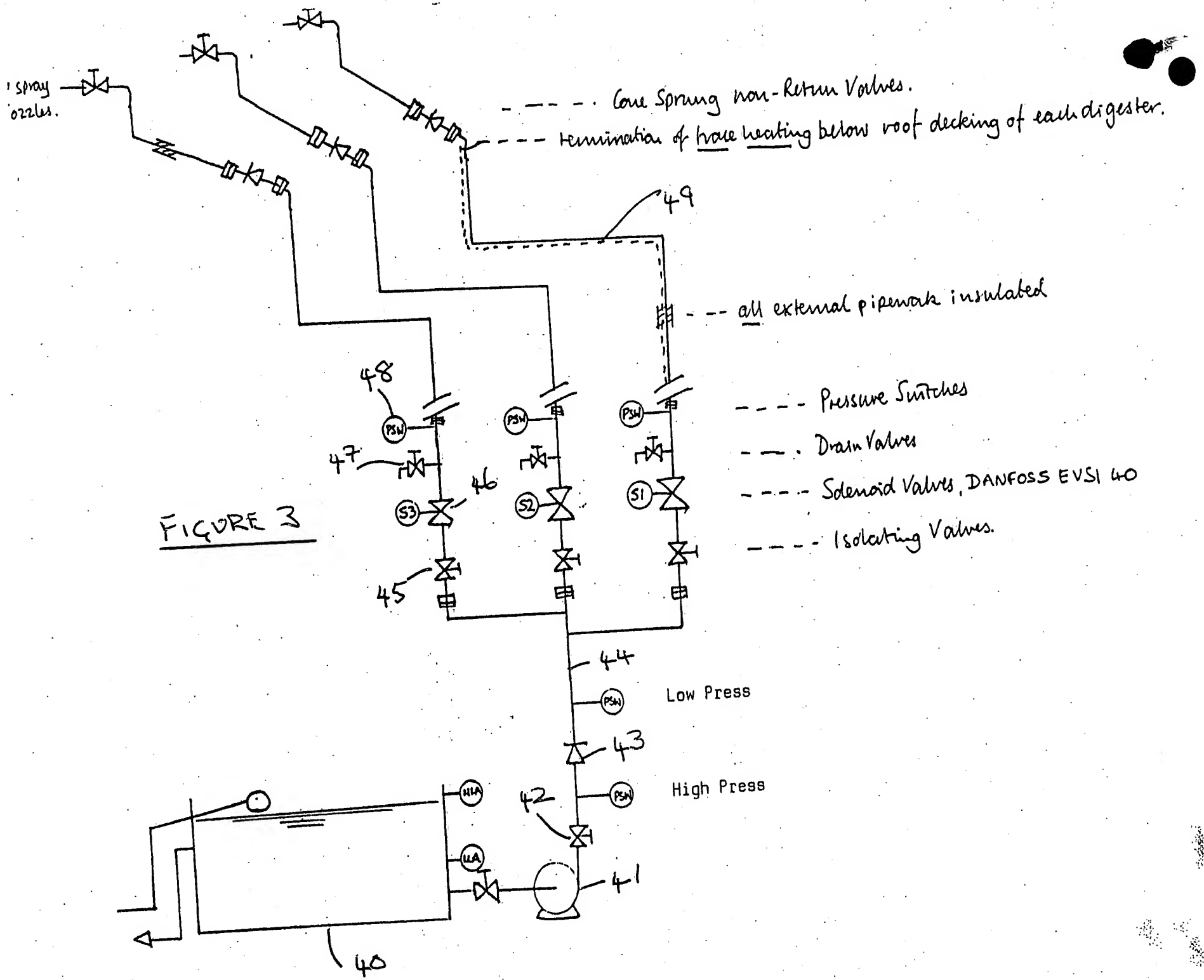

spray nozzles.
Cone Sprung non-Return Valves.
Termination of trace heating below roof decking of each digester.
49
all external pipework insulated
48
47
46
45
PSW
S1
S2
S3
Pressure Switches
Drain Valves
Solenoid Valves, DANFOSS EVSI 40
Isolating Valves.
44
Low Press
43
High Press
42
41
40
HLA
LLA

FIGURE 3

Document Filed By:
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